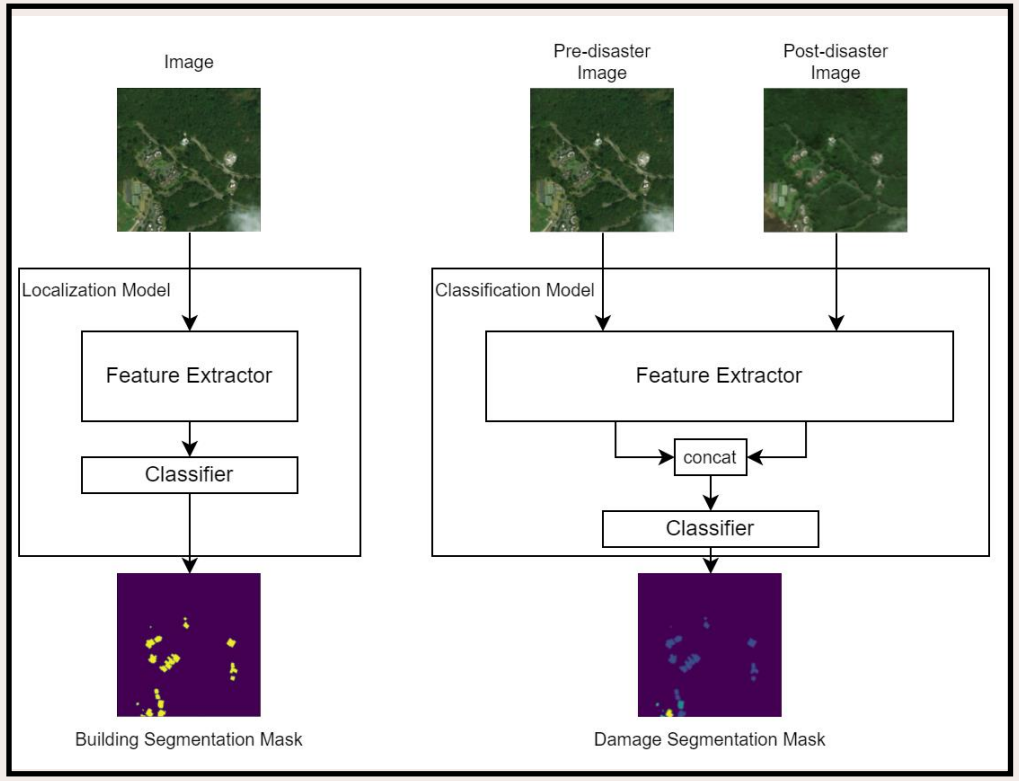
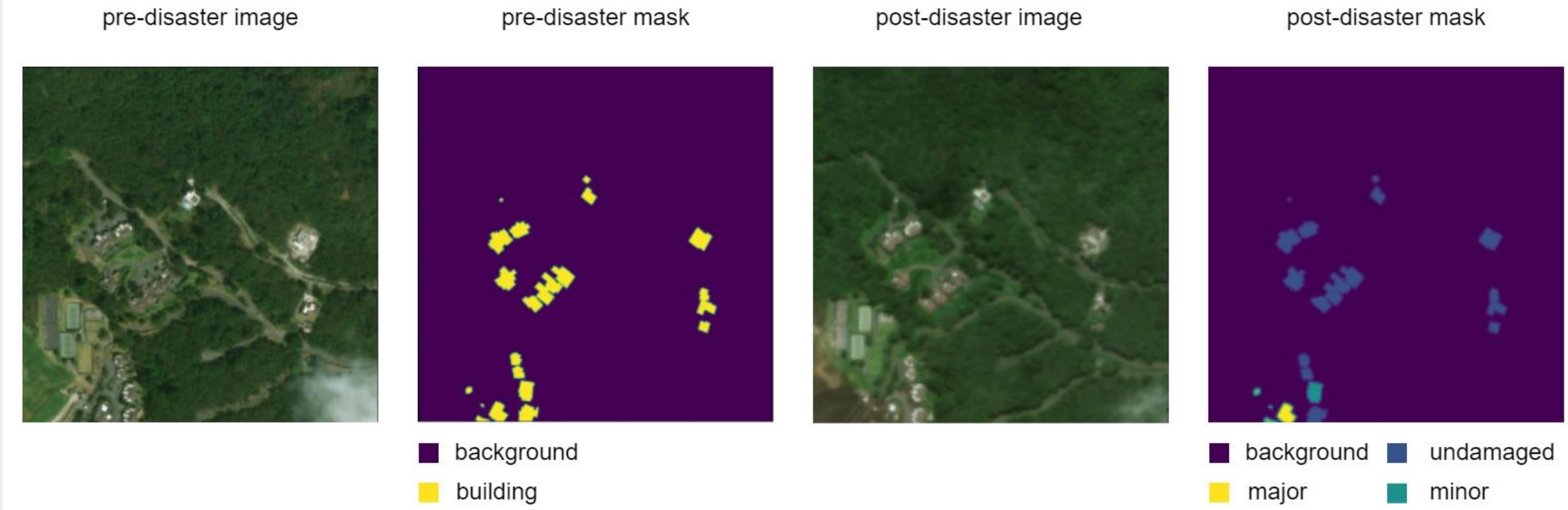
MetaDamageNet

Using Deep Learning To Identify And Classify Damage In Aerial Imagery

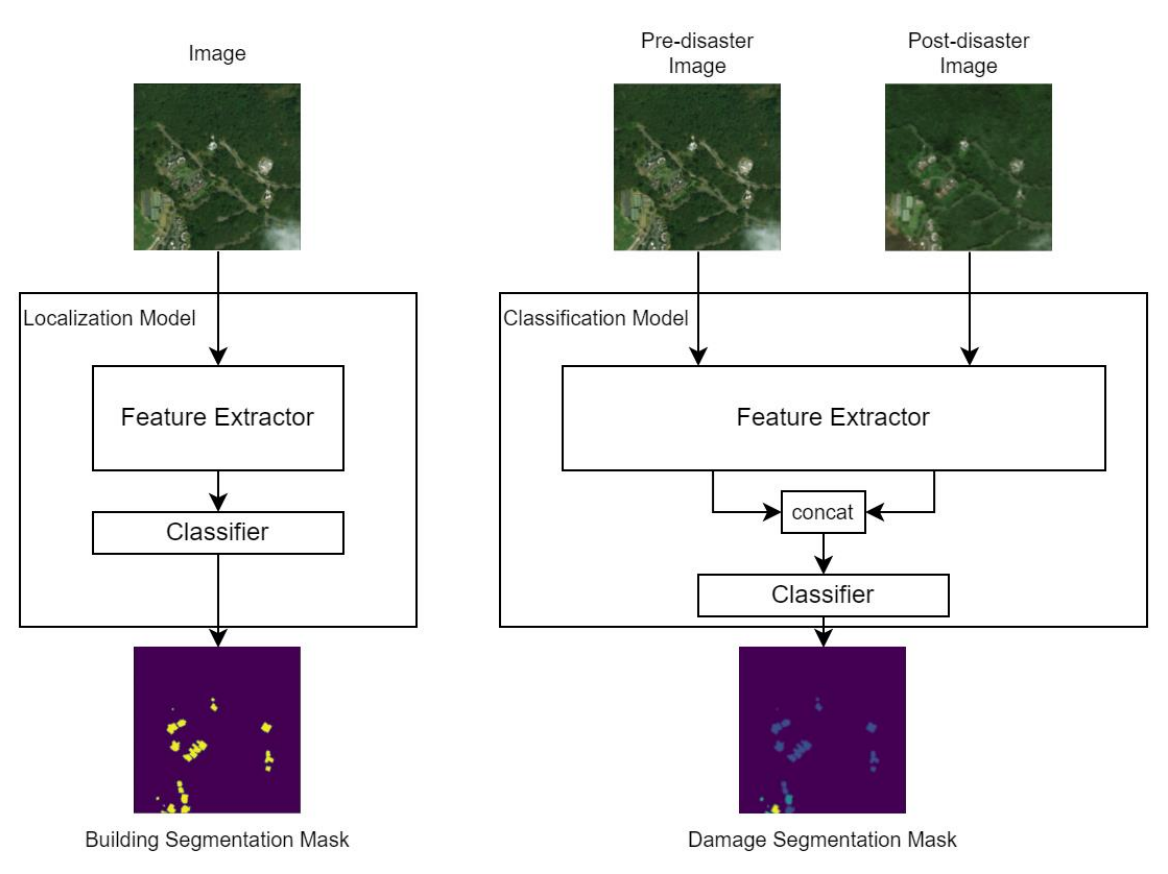
Nima Afshar



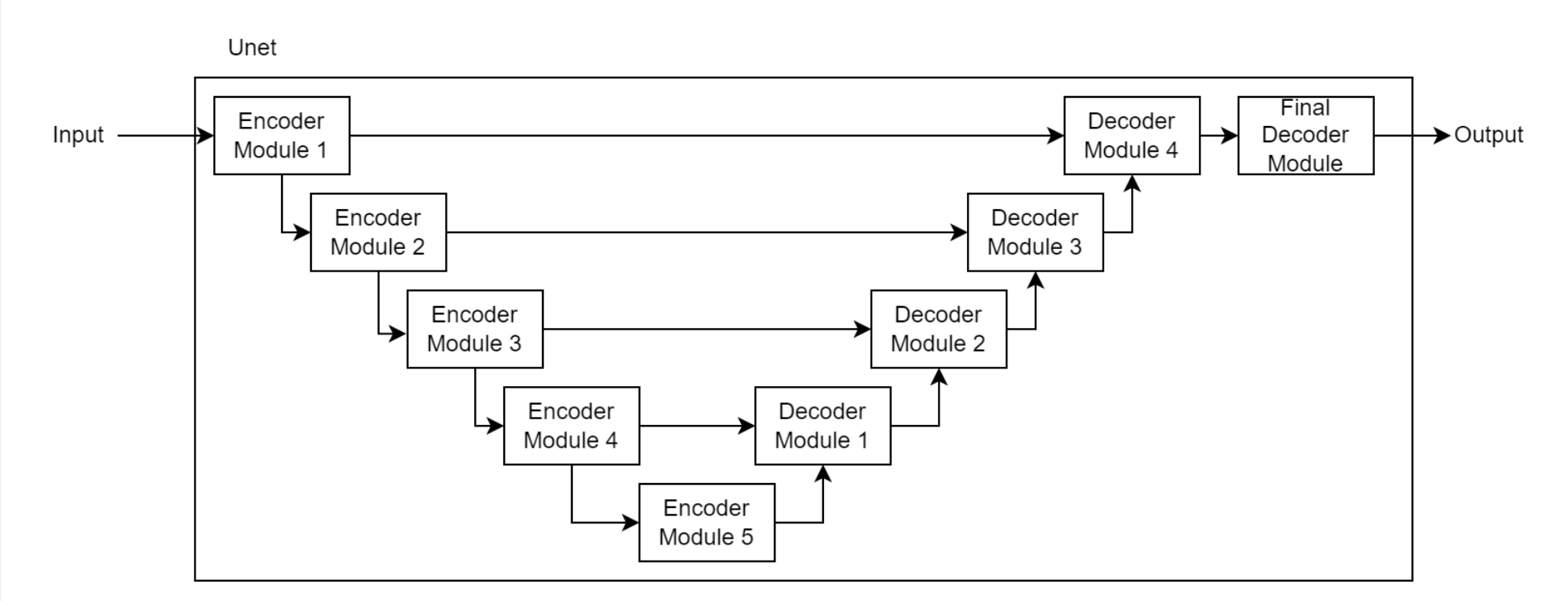
Dataset & Problem Definition



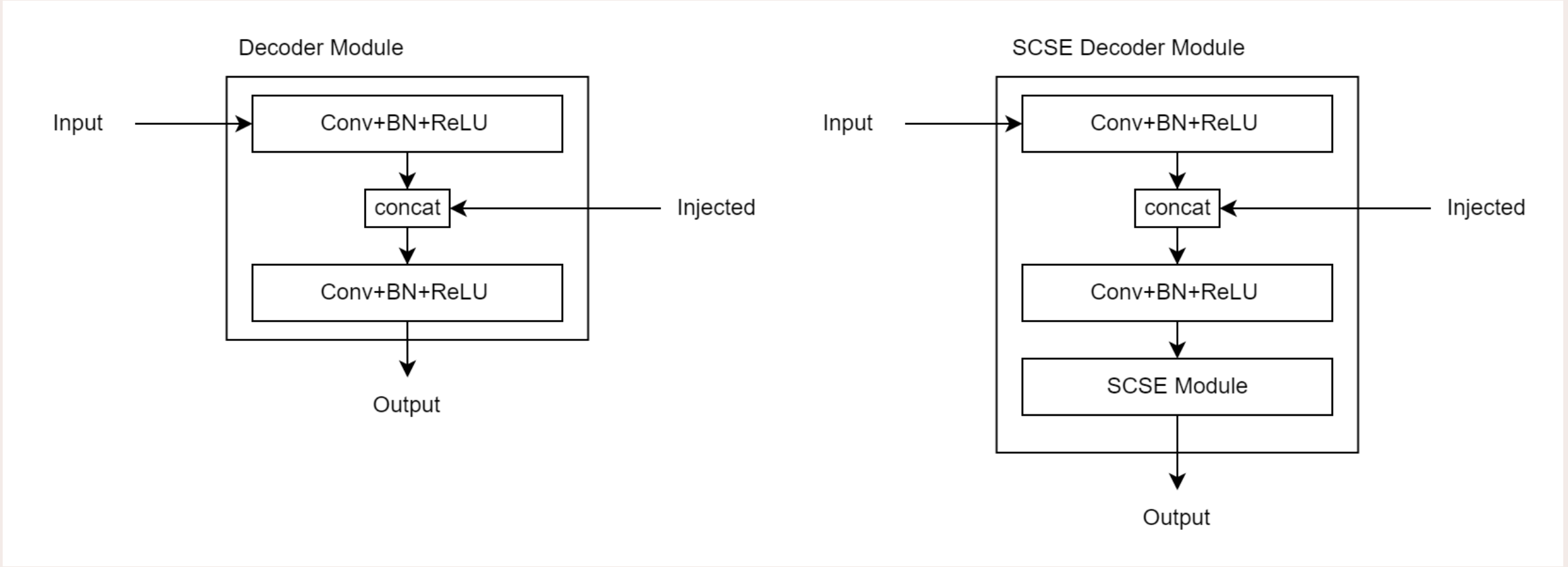
Methodology



U-models


Unet
Input
Encoder Module 1
Encoder Module 2
Encoder Module 3
Encoder Module 4
Encoder Module 5
Decoder Module 1
Decoder Module 2
Decoder Module 3
Decoder Module 4
Final Decoder Module
Output

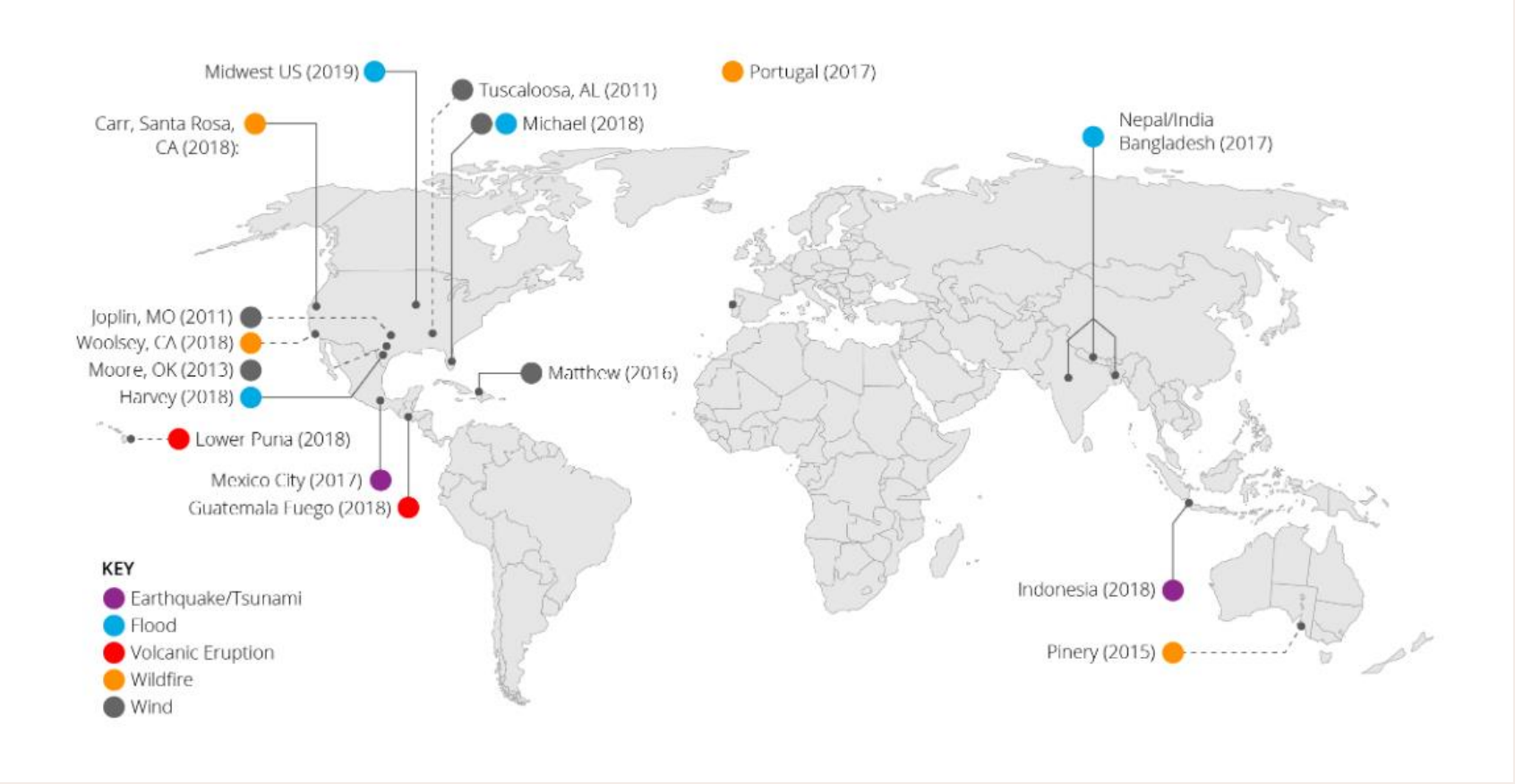
Decoder Modules



Backbone of Unet

model		#params	Batch Normalization	DecoderType
name	backbone			
Resnet34Unet	resnet_34	25,728,112	No	Standard
SeResnext50Unet	se_resnext50_32x4d	34,559,728	No	Standard
Dpn92Unet	dpn_92	47,408,735	No	SCSE - concat
SeNet154Unet	senet_154	124,874,656	No	Standard
EfficientUnetB0	efficientnet_b0	6,884,876	Yes	Standard
EfficientUnetB0SCSE		6,903,860	Yes	SCSE - no concat
EfficientUnetWideSEB0	efficientnet_widese_b0	10,020,176	Yes	Standard
EfficientUnetB4	efficientnet_b0	20,573,144	Yes	Standard
EfficientUnetB4SCSE		20,592,128	Yes	SCSE- no concat
SegFormer	segformer_512*512_ade	3,714,401		

Meta Learning



The MAML Algorithm

Algorithm 1 Model-Agnostic Meta-Learning

Require: $p(\mathcal{T})$: distribution over tasks
Require: α, β: step size hyperparameters
1: randomly initialize θ
2: **while** not done **do**
3: Sample batch of tasks $\mathcal{T}_i \sim p(\mathcal{T})$
4: **for all** $\mathcal{T}_i$ **do**
5: Evaluate $\nabla_\theta \mathcal{L}_{\mathcal{T}_i}(f_\theta)$ with respect to K examples
6: Compute adapted parameters with gradient descent: $\theta_i' = \theta - \alpha \nabla_\theta \mathcal{L}_{\mathcal{T}_i}(f_\theta)$
7: **end for**
8: Update $\theta \leftarrow \theta - \beta \nabla_\theta \sum_{\mathcal{T}_i \sim p(\mathcal{T})} \mathcal{L}_{\mathcal{T}_i}(f_{\theta_i'})$
9: **end while**

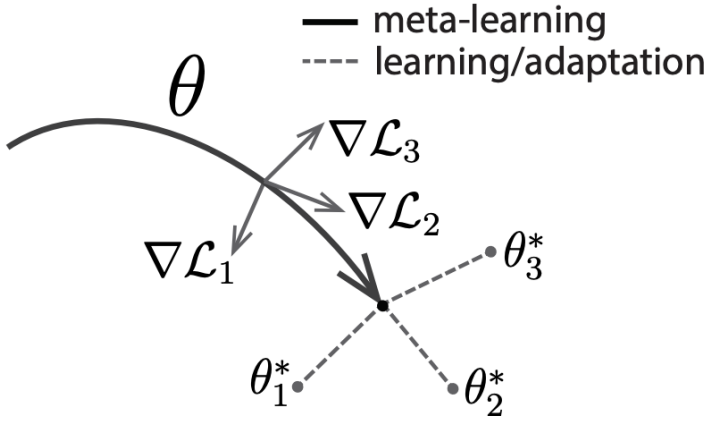
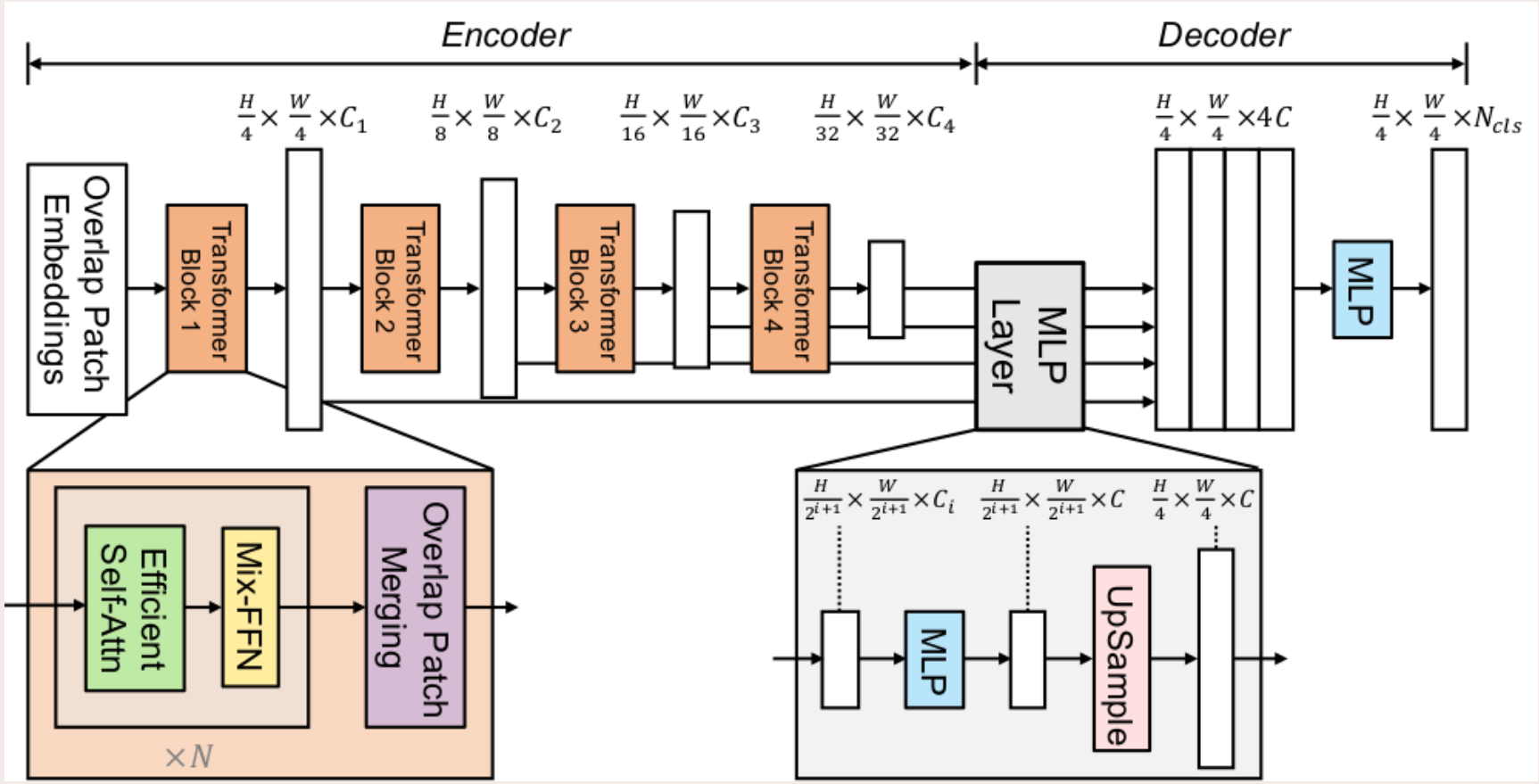


Figure 1. Diagram of our model-agnostic meta-learning algorithm (MAML), which optimizes for a representation θ that can quickly adapt to new tasks.

SegFormer


Encoder
Decoder
$\frac{H}{4}\times\frac{W}{4}\times C_1$
$\frac{H}{8}\times\frac{W}{8}\times C_2$
$\frac{H}{16}\times\frac{W}{16}\times C_3$
$\frac{H}{32}\times\frac{W}{32}\times C_4$
$\frac{H}{4}\times\frac{W}{4}\times 4C$
$\frac{H}{4}\times\frac{W}{4}\times N_{cls}$
Overlap Patch Embeddings
Transformer Block 1
Transformer Block 2
Transformer Block 3
Transformer Block 4
MLP Layer
MLP
Efficient Self-Attn
Mix-FFN
Overlap Patch Merging
$\times N$
$\frac{H}{2^{i+1}}\times\frac{W}{2^{i+1}}\times C_i$
$\frac{H}{2^{i+1}}\times\frac{W}{2^{i+1}}\times C$
$\frac{H}{4}\times\frac{W}{4}\times C$
MLP
UpSample

Loss Functions

- Dice Loss

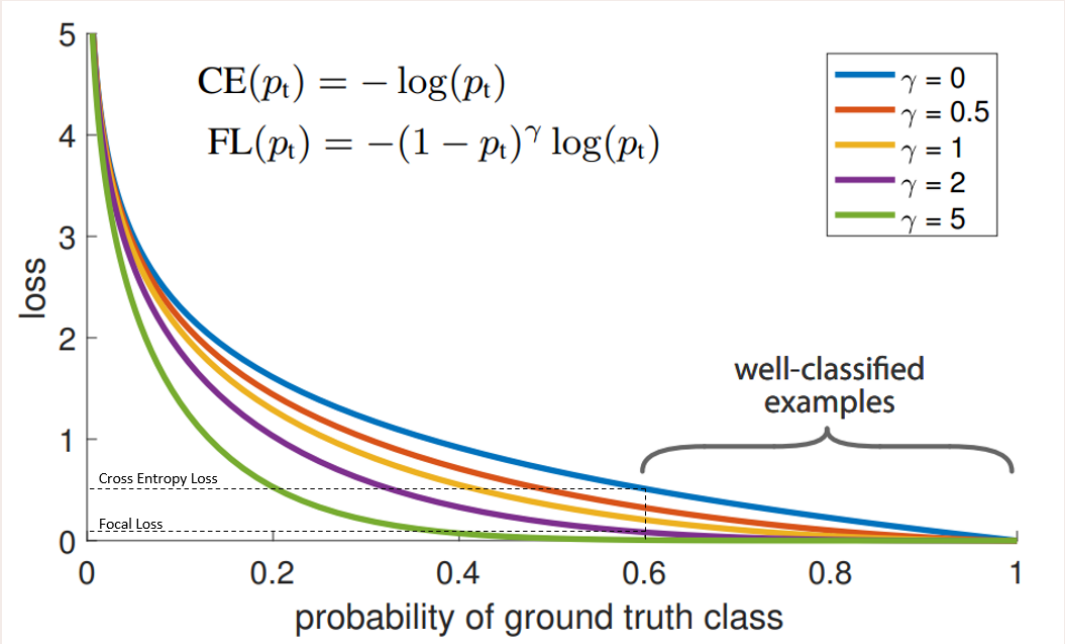
$$Dice\ Loss(p,t) = 1 - dice(p,t)$$

$$dice(A,B) = 2\frac{A \cap B}{A + B}$$

- borders

- Focal Loss

$$FL(p_t) = -\alpha_t(1-p_t)\gamma log(p_t).$$



Evaluation

- Building Localization

$$Dice(P,Q) = 2.\frac{P \cap Q}{P+Q}$$

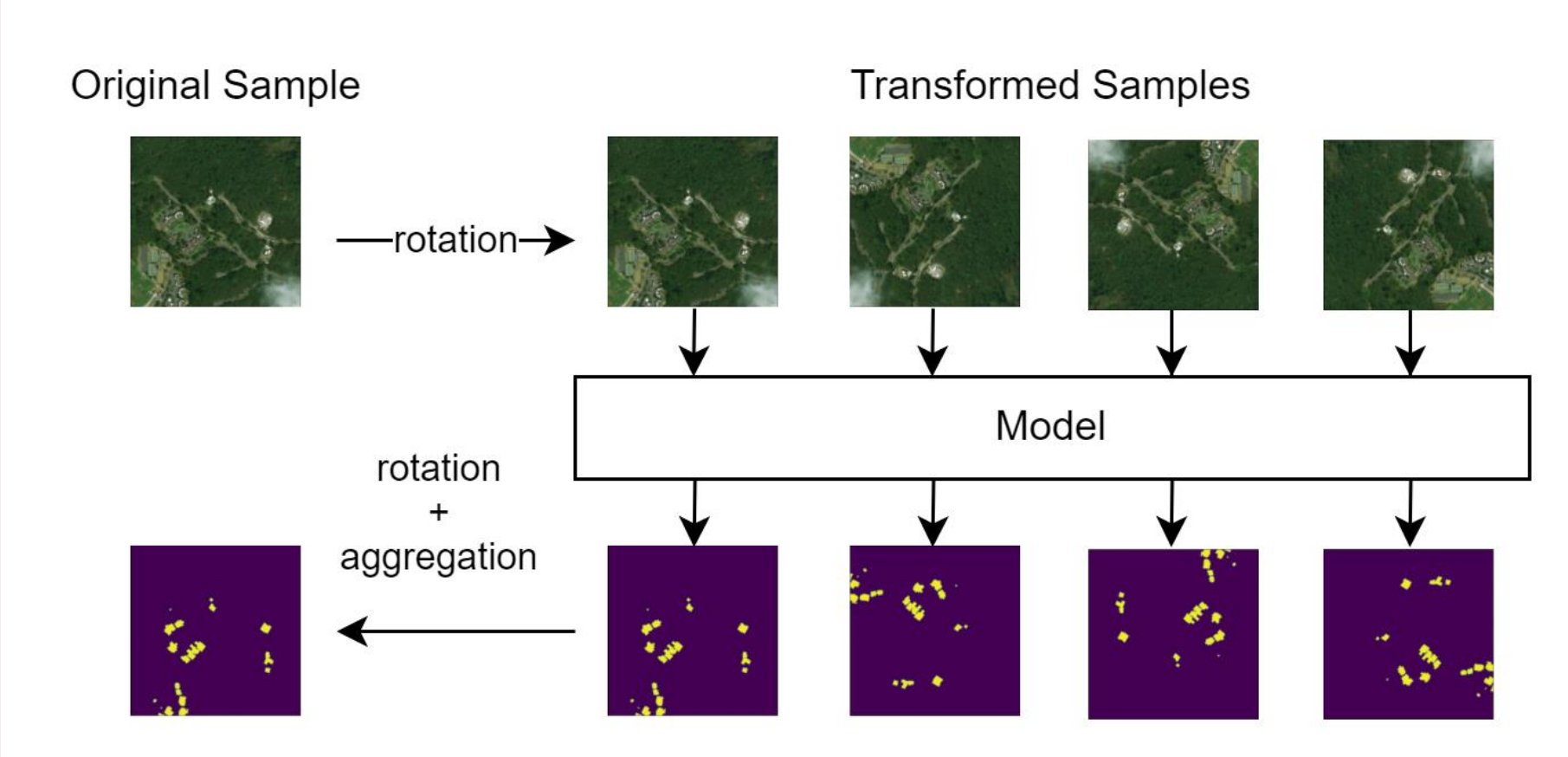
$$F1(P,Q) = \frac{2TP}{2TP+FP+FN}$$

- Damage Classification

$$score = 0.3 \times F1_{LOC} + 0.7 \times F1_{DC}$$

$$F1_{DC} = 4/(\frac{1}{F1_1+\epsilon} + \frac{1}{F1_2+\epsilon} + \frac{1}{F1_3+\epsilon} + \frac{1}{F1_4+\epsilon})$$

Test-Time Augment



Results - Localization

model	version	seed	Test Score		Validation Score	
TTA			-	+	-	+
Resnet34Unet	1	0	0.6590	0.6643	0.6542	0.6590
		1	0.6690	0.6799	0.6664	0.6768
		2	0.6839	0.6903	0.6812	0.6858
		mean agg.	0.6772	--	0.6720	--
SeResnext50Unet	tuned	0	0.6963	0.7002	0.6957	0.6967
		1	0.7036	0.7074	0.6916	0.6971
		2	0.7084	0.7087	0.6981	0.7027
		mean agg.	0.7088	--	0.6998	--
Dpn92Unet	tuned	0	0.6796	0.6849	0.6776	0.6830
		1	0.6297	0.6335	0.6335	0.6322
		2	0.6708	0.6722	0.6662	0.6714
		mean agg.	0.6597	--	0.6637	--
SeNet154Unet	1	0	0.7348	0.7393	0.7261	0.7302
		1	0.7253	0.7319	0.7100	0.7163
		2	0.7326	0.7360	0.7217	0.7252
		mean agg.	0.7409	--	0.7264	--

EfficientUnetB0	Standard	0	0.7692	0.7739	0.7634	0.7666
		1	0.7685	0.7723	0.7638	0.7662
		2	0.7704	0.7740	0.7625	0.7666
	SCSE	0	0.7723	0.7749	0.7644	0.7674
		1	0.7707	0.7737	0.7628	0.7682
		2	0.7721	0.7765	0.7647	0.7711
	Wide-SE	0	0.7719	0.7758	0.7662	0.7700
		1	0.7754	0.7754	0.7664	0.7682
EfficientUnetB4	Standard	0	0.7755	0.7797	0.7702	0.7724
	SCSE	0	0.7811	0.7826	0.7718	0.7743
SegFormerB0	512*512_ade	0	0.7602	0.7281	0.7543	0.7214
		1	0.7569	0.7223	0.7533	0.7189
		2	0.7605	0.7301	0.7545	0.7250

Results - Classification

model	version	seed	Test Score		Validation Score	
TTA			-	+	-	+
Resnet34Unet	tuned	0	0.1090	0.0806	0.1119	0.0831
		1	0.1466	0.1174	0.1264	0.0997
		2	0.1314	0.1101	0.1324	0.1082
		mean agg.	0.0860	--	0.0832	--
SeResnext50Unet	tuned	0	0.6164	0.6152	0.6397	0.6347
		1	0.6135	0.6069	0.6012	0.5991
		2	0.6319	0.6422	0.6271	0.6361
		mean agg.	0.6360	--	0.6301	--
Dpn92Unet	tuned	0	0.6564	0.6657	0.6387	0.6441
		1	0.6233	0.6343	0.5869	0.5813
		2	0.6246	0.6252	0.6075	0.6138
		mean agg.	0.6460	--	0.6258	--
SeNet154Unet	tuned	0	0.6916	0.7034	0.6684	0.6722
		1	0.6216	0.6342	0.5889	0.6123
		2	0.6868	0.6949	0.6520	0.6479
		mean agg.	0.6954	--	0.6596	--

EfficientNetB0	Standard	0	0.7576	0.7571	0.7606	0.7505
	SCSE	0	0.7591	0.7525	0.7497	0.7399
	Wide-SE	0	0.7726	0.7667	0.7769	0.7737
EfficientUnetB4	Standard	0	0.7732	0.7679	0.7684	0.7589
	SCSE	0	0.7746	0.7650	0.7740	0.7635
SegFormer	Standard	0	0.7574	0.7380	0.7385	0.6993

Conclusion & Discussion

- Challenges
- Training Details
- Future Ideas
- Augmentations Framework
- Discussion

Thank You